ECDYSIS IN TMETOCERA OCELLANA SCHIFF.

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An examination of the literature on the Bud-moth, (*Tmetocera ocellana* Schiff.) reveals little concerning the moulting of such a common pest. In fact there has been very little investigation of the moulting of any of the Lepidoptera and especially of the measurement of the moulted head capsules. In response to the need of detailed study on this phase of the life history, the writer has assembled the following notes.

A brief summary of the development of the subject may be of value. Several writers have previously called attention to the moulting habit of the Bud-moth, but there still remains an opportunity for considerable investigation along this line. Mr. H. G. Dyar, of the United States National Museum, several years ago made a valuable contribution in the form of a series of head measurements of the first five instars of the Bud-moth larvæ. His notes were published by Prof. M. V. Slingerland (1893).* Further information has been supplied by Prof. Slingerland in the same bulletin. Mr. G. E. Sanders and A. F. Dustan (1919)† in their work on the Bud-moths of Canada, have added likewise to our knowledge of the ecdysis of *T. ocellana* Schiff. The numerous other papers, chiefly of economic importance, add very little to the study.

METHOD OF STUDY.

This study has been divided into four parts. (1) The moulting process, (2) The number of moults, (3) The measurement of the moulted head capsules, (4) The shape and structure of the head capsules.

The larvæ used in obtaining these records were hatched from eggs laid in confinement and were examined and fed at least once a day. Each larva was placed in a separate four dram vial with a small portion of the leaf as food. As soon as the moults occurred, the head capsules were removed and placed in individual jelletin capsules and properly labelled by means of colored papers according to the number of the moult. All measurements were made at the end of the season.

THE MOULTING PROCESS.

The process of moulting, as in all insects, is a delicate one. The larva at this time is weak and helpless and very susceptible to injury. Nature, however, has provided ample means of protection during this period. The larva never moults in the open, but always conceals itself in some manner. Sometimes it may be a curled leaf with a few silken threads, but more often it forms a well constructed silken moulting case. This case may be entirely closed or partly open at one or both ends. The larva often moults within its feeding case, which serves as a means of protection during the entire life of the larva, but at this time provides special protection. As a rule, moulting occurs in a closed moulting case.

The feeding case is composed of a mass of silken threads tightly woven together into a trumpet shaped tube somewhat resembling the feeding tube of the Apple leaf crumpler (*Mineola indigenella* Zell.) but is smaller and neater. The frass is utilized by the larva and woven into this silken tube, giving it a blackish color and forming a hard protective covering. Immediately following a moult, within the feeding case, the moulted skin and head capsule will be found inside the feeding tube. These are pushed by the larva to the end of the case where they become entangled with the silken threads of the case and are later imbeded in the silk and the frass of the case.

It is possible to determine when a moult is approaching. Several hours or even a day before hand the approaching moult is indicated by a whitish membraneous area between the head and the prothoracic shield and a decided constriction at this point. The moult follows shortly afterwards.

When ready to moult the skin loosens at the thorax and the old integument, including the prothoracic shield, moves off the posterior end of the larva. The larva frees itself by crawling out of the skin. The head capsule comes off separately and in several cases under observation popped off about the same time the larva freed itself from its skin. Only a short time elapses from the first indication of a moult until the skin is shed. In one instance a larva was in the process of the fourth moult at 4:52 P. M., the old head capsule had worked half

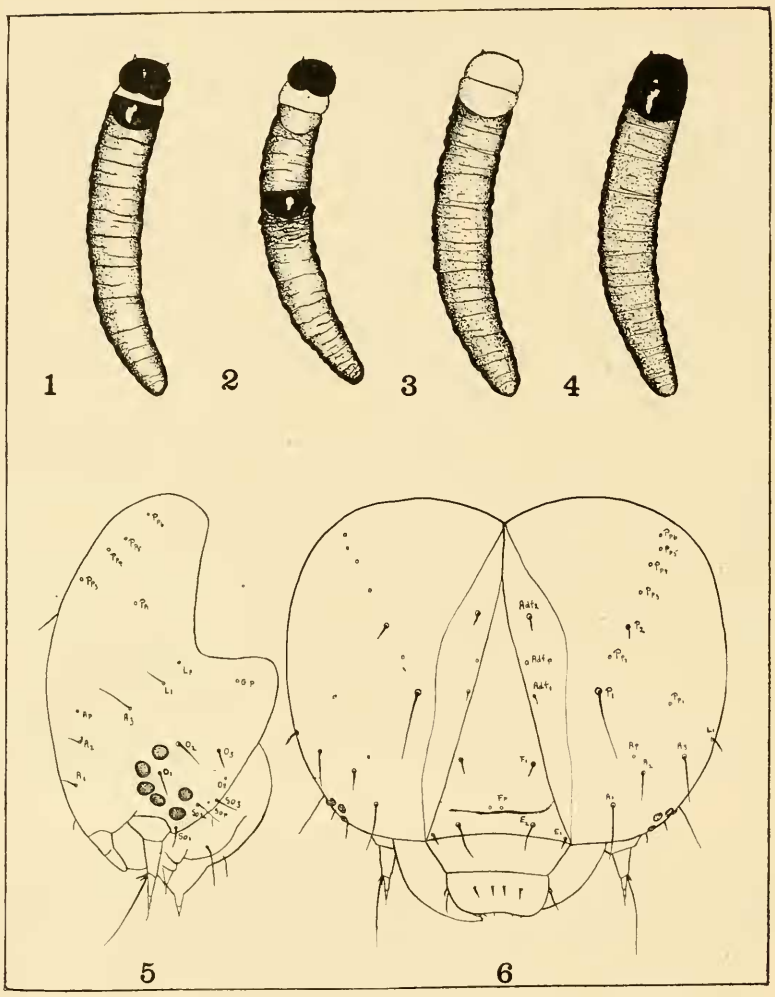

FIG. I.

1, Larva showing first indication of approaching moult. 2, Larva in process of moult. 3, Larva immediately after moult. 4, Larva showing head and thorax fully colored. 5, Lateral aspect of head capsule. 6, Cephalic aspect of head capsule.

Adf_1, Adf_2—Adfrontal setæ.
Adfp—Adfrontal puncture.
F—Frontal seta.
Fp—Frontal puncture.
E_1, E_2—Epistomal setæ.
A_1, A_2, A_3—Anterior setæ.
Ap—Anterior punctures.
L_1—Lateral setæ.
Lp—Lateral puncture.
P_1, P_2, P_3—Posterior setæ.
Pp_1, Pp_2—Posterior punctures.
O_1, O_2, O_3—Ocellar setæ.
Op—Ocellar punctures.
So_1, So_2—Sub ocellar setæ.
Gp—Genæ puncture.
SOp—Sub ocellar puncture.

way off the head and the skin had worked part way off the body so that the prothoracic shield rested over the second abdominal segment. At 4:55 P. M. of the same day the head capsule was cast and at 4:59 P. M. the larva succeeded in freeing itself from its skin.

NUMBER OF MOULTS.

The number of moults apparently varies in different parts of the country. Mr. G. E. Sanders (1919)* found in Canada that there are only seven moults. The majority of the larvæ entered their winter quarters in the third instar, while a few moulted a third time and entered hibernation as fourth instar larvæ. In Pennsylvania the writer has obtained ten larval moults. The majority of the larvæ enter hibernation in the ninth instar, the other two moults occurring the following spring. A small percentage hibernate in the eighth instar. Considerable variation may be expected where the number of instars are as high as in the Bud-moth.

MEASUREMENT OF HEAD CAPSULES.

In moulting, the head capsule and thoracic shield, because of their chitinous nature, retain their original shape and thus lend valuable characters for a study of this kind. Advantage was taken of this fact and the head capsules of a number of each instar were preserved and measured.

Table of Measurements of Head Capsules of *T. ocellana* Schiff.

Instar	Number of head capsules measured	Average Length	Average Width	Dyar's* Measurements
1st	30	.142 mm.	.216 mm.	.225 mm.
2nd	34	.188 mm.	.275 mm.	.288 mm.
3rd	21	.258 mm.	.363 mm.	.363 mm.
4th	16	.299 mm.	.436 mm.	.43 mm.
5th	27	.356 mm.	.513 mm.	.56 mm.
6th	28	.404 mm.	.572 mm.	.....
7th	22	.457 mm.	.645 mm.	.....
8th	15	.510 mm.	.733 mm.	.....
9th	23	.517 mm.	.760 mm.	.....
10th	16	.629 mm.	.975 mm.	1.05 mm.

* Cornell Bull. 50, 1893.

SHAPE OF THE HEAD CAPSULES.

There are certain differences in the shape of the head capsules that help to distinguish some of the instars. The head capsule of the first instar is distinctly flattened while the capsules of the remaining instars are rounded and easily separated. A comparison of the heads further show that those of the first seven instars are proportionally longer than broad, while the eighth, ninth and tenth larval heads are proportionally broader than long. These differences in shape, as well as the differences in size, aid in determining the different instars.

REFERENCES.

*. **Slingerland, M. V.** The Bud-moth, Cornell Bull. 50, pp. 1-29, 1893.

†. **Sanders, G. E.** and **Dustan, A. G.** The Apple Bud-moths and their Control in Nova Scotia, Dom. Canada Dept. Agric. Bull. 16, 1919.